This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

T
173
.M82

A 848,155

Prof. C. E. [illegible]

DESCRIPTION

of the

Collections of Scientific Appliances instituted for the study of Mechanical Art in the workshops of the *Imperial* Technical School of Moscow.

MOSCOW.

1876.

Т
173
N182

Дозволено цензурою. Москва, Марта 6 дня 1876 г.

T
1772

Дозволено цензурою.

Introduction.

The *Imperial* Technical School of Moscow is a high class Special School principally intended for the education of Mechanical Constructers, Mechanical Engineers and Technical Engineers.

The School consists of two divisions, general and special, each of which has a course of three years. The special division is divided into three branches: Mechanical Construction, Mechanical Engineering and Technological Engineering.

The three years'course of the general division embraces the following subjects: Religion Free hand and Linear Drawing, Descriptive Geometry, General Physics, Zoology, Botany, Mineralogy, Chemistry, Geodesy, Analytical Geometry, Higher Algebra, Differential and Integral Calculations, General Mechanics, Drawing of Machine-parts, the French and German Languages, i. e. all Scientific subjects the previous knowledge of which is required from the pupils of all the three following Branches.

In the special department, the three years'course of the three branches contains the following subjects: Organic and Analytical Chemistry, Metallurgy, Practical Physics, Mechanical and Chemical Technology, Technics of Wood and Metals, Analytical Mechanics, Construction of Machines, Practical Mechanics, Railway Construction, Engineering and Constructive Art, Projecting and Estimating of Machines, Works and Mills, Industrial Statistics and Book-keeping.

Every one of the appointed sciences is taught fully or in a condensed form, according as it is considered a fundamental or collateral subject of the given branch. The students of all the classes are occupied during a stated time in practical work in the laboratories and mechanical workshops.

The school has also a preparatory division, of three classes, with the same curriculum as the higher classes of commercial schools, and is intended for such pupils as, by any reason whatever, have not been enabled to pass through the full course of the commercial or of the classical schools.

All the pupils are classed as follows:

Foundation Boarders,
Private Boarders,
Day Scholars,
Foreign Hearers.

At present the school contains 100 Foundation Boarders, 200 Private Boarders, 150 Day Scholars and 136 Foreign Hearers, in all 586 pupils.

The annual charge is, —

for Boarders	225	dollars,
Day Scholars	75	» »
Foreign Hearers	55	» »

Admission into the School as boarder or day scholar is obtained by competitive examination, in accordance with the ordained programme.

Pupils who have passed through the full school course of the Gymnasiums may be admitted without further examination to the lectures of the second general class of the School, but pupils of the last class of the Gymnasiums, who have not passed their final examination, are admitted only to the first general class of the School.

The pupils wear the appointed half-military uniform.

Pupils who have obtained in the school the appointed grades receive acknowledged rights in the service of the government.

The School is maintained by funds from the following sources: percentage on funded capital *), fees of private boarders and foreign hearers, and profits received from the Mechanical Works.

The annual receipts of the School amount to 160000 doll.
» annual expenses » » » » 140000 »
The Technical School is under the immediate patronage of ***Their Imperial Majesties.***

---

*) The School capital amounts to about 2030000 dollars.

Superior: ***His Imperial Highness Prince Peter of Oldenburg.***

Honorary Curator: Prince *Sergey Obolensky-Neledinsky-Meletsky*, Master of the Horse and Actual Councillor of State.

Honorary Members of the *School Council*: *His Imperial Highness* the Grand Duke *Konstantine Nicolaevitch*, *His Imperial Highness* Prince *Leichtenberg*, Count *Strogonoff*, Academician *Chebisheff*, General *Selony*, *Peter Kotchubay*, and Councillor *Goubonin.*

Director of the School: *Victor Della-Voss*, Actual Councillor of State.

Inspector: Councillor *Katsaouroff.*

Professors:

Higher Mathematics: *Letnikoff* (Doctor of Mathematics of the Moscow University and Leipsic University).

Practical Mechanics: *Orloff* (Magister of Mathematics).

Construction of Machines: *Lebedeff* (Magister of Applied Mathematics).

Chemical Technology: *Kossoff* (Magister of Technology) and *Arkhipoff* (Doctor of Technology).

Constructive and Enginering Arts: *Panaieff* (Civil Engineer).

Projecting of Machines and Works: *Aeschlimann* (Technical Engineer).

General Chemistry: ***Akhmatoff*** (Magistrand).

General and Applied Physics: ***Vladimirsky***.

Technology of Fibrous Material: ***Dmitrieff*** (Technical Engineer).

Docents: Analytical Mechanics: ***Joukoffsky*** (magistrand).
Analytical Chemistry: ***Porjesinsky*** (magister).

Tutors: ***Michaleffsky***, ***Davidoffsky***, ***Weidengammer*** (Engineers).

Head of Laboratorie: Doctor ***Reiman***. His Adjuncts. ***Duboffsky*** and ***Zimmermann***.

Assistants: ***Malesheff*** (Mechanical Engineer) and ***Romanenko***.

Masters:

Religion: Priest ***Slavsky***, Pastor ***Kettler***. Russian Language: ***Vinogradoff***. Lower Mathematics: ***Joukoffsky***, ***Chirkoff***. Linear Geometry: ***Michaleffsky***. French Language: ***Clavel***. German Language: ***Bick***. Geography: ***Brizgaloff***. Natural History: ***Mishaeff***. Book-Keeping: ***Psistcheff***. Drawing: ***Bajenoff***. Plans of Details of Machines: ***Ganss***. Free hand Drawing: ***Tourchaninoff***. Statisticks: ***Fuchs***. Singing: ***Orloff***. Gymnastics: ***Kriloff***.

Auxiliaries to Instruction. The School possesses a special library containing more than six thousand volumes of works on Specialities, a cabinet of physics, two chemical laboratories, a cabinet of mechanical models, a cabinet of natural history, an extensive mechanical works with separate smithy and foundry, and also school workshops.

Almost the whole of the collections exhibited by the School at the exhibition of Philadelphia are immediately connected with the school workshops and we shall therefore endeavour to give a few details concerning the latter.

No one will deny that a close acquaintance with hand labour, and, in general, practical experience in mechanical works, are matters of the utmost importance to every engineer *). The drawings of an engineer thus trained will always be distinguished by solidity and that practical judgment which is the result not only of the study of scientific truths, but also of the acquirement of a certain familiarity in their application to practice. That the knowledge of hand labour is of extreme importance to a young man, devoting himself to technical activity, and that it is considered an absolute necessity to him, we are convinced by the circumstance, that the greater number of the polytechnical schools of western Europe demand from the students, who enter them, either a previous stay, of a certain duration, at some works of industry, or issue to them a diploma, attesting their accomplishment of the course, after they are in position to show, that they have been occupied practically for a definite period at some such works on their leaving the school.

If we contemplate the matter itself more profoundly and acquaint ourselves more closely with the circum-

---

*) We speak here of Mechanical Engineers and Constructers.

stances of the practician at private works and mills, we must, disregarding exceptional cases, since it is not they who form the rule, arrive at the sad conclusion, that a young man, desiring to acquire practical experience in a short time and without the aid of an experienced guide, loses, at a private works, nine-tenths of his whole time entirely unprofitably. As we are at present addressing persons well acquainted with this matter, we do not consider it necessary to bring forward arguments in support of our statement. The practical information, acquired in a works by a young man, entering a polytechnical school, is very inconsiderable and therefore does not possess the desired significance.

Such information is, on account of its defectiveness, of little assistance in promoting the study at school of Practical Mechanics, the construction of Machines or the drawing up of plans and estimates for mills and works.

A young man on leaving a polytechnical school should endeavour to carry on his practical education; should fix upon some mill or works in which, being, in the majority of cases of course, left to his own initiative, he may find place and opportunity for his further self-education.

At this moment, so critical in the career of the youthful engineer, the insufficiency of material resources is the cause that the majority take service, at a very low rate of remuneration, as draughtsmen in the drawing office of a mechanical works, or in the drawing offices of railway companies; others more fortunate enter a works in the quality of artizans; but even they are hardly to be envied, simply from the fact that in the majority of cases the speciality of the first works, which they happen to enter, becomes their own speciality through life. An experienced observer will find no difficulty in perceiving all the inconveniences to a technical education, which arise as the result of such an order of things. Let us explain this by examples. A young man, having received thorough scientific preparation in a polytechnical school, has entered as artizan practician some extensive joiner works and in a year or two begins to serve in the capacity of a workman, receiving pay from the works. If, from any circumstance whatever, he becomes deprived of his place, he finds it necessary for him to seek another in a similar joiner works, or else to enter again as practician in another speciality, for instance a locomotive, boiler or other works. The material resources of young men preclude, in the majority of cases, the possibility of their deciding on the latter alternative.

If the observant Directors of Polytechnical Schools should take upon themselves the work of following the industrial career of the contingent of their pupils, who on leaving school enter a drawing office, they would easily perceive that those young people experience extreme difficulty when they are once engaged there in leaving such an office, and in the majority of cases remain draughtsmen all their lives. In such offices a young man acquires but very inconsiderable technical information, neither can they in any way serve him as practical schools for his further self-instruction. And we must here observe also that the more extensive the works and consequently the drawing office attached, the fewer are the advantages offered to the young practician, since he has to do with an institution in which division of labour, forming an essential principle, will not admit of his becoming speedily acquainted with the general progress of work We cannot but add that this principle having become latterly extensively applied in all large works and mills, though on the one hand bringing considerable material advantages to the proprietors, has, on the other, greatly influenced the depreciation of the level of technical knowledge among the workmen, by confining that knowledge within the limits of narrow specialization.

The technical education afforded to young men in almost all the Polytechnical Schools of Europe leaves, theoretically speaking, little to desire, but is exceedingly imperfect practically, and demands the particular attention of those persons who are entrusted with such instruction.

The peculiar circumstances by which the young people who have finished the course of the Polytechnicums find themselves surrounded, do not admit before their entering upon an active life, of the acquirement of even a superficial general practical education, but place them in the necessity of devoting all their activity from the first day of their leaving school, and often their whole life, to a narrow speciality. The attention of the Directors of Polytechnical Schools has often been drawn to this and attempts have frequently been made to familiarize young people at school with the practical work of mechanics, but all those endeavours proved to be unattended with success from the following reasons:

1. The school workshops for the practical occupation of the students were constructed on a very miniature and inconsiderable scale.
2. The consequent want of room in these workshops did not admit of all the students being accupied at the same time and therefore their attendance was not obligatory, while the majority of the professors and masters expressed their disapprobation of such employment.
3. There existed no systematical method of practical instruction in the workshops similar to that which had been applied to the practical teaching in the chemical laboratories.
4. The material resources assigned for the maintenance of the school workshops were very inadequate.
5. The time allowed for the full course of study in the Polytechnical Schools was insufficient to admit of the combination, in that course, of theoretical with practical instruction in technology.

Thougt there have appeared some literary articles against the introduction of practical instruction with workshops into the higher technical schools, yet it is our subjective opinion that those articles appeared only in defence of the existing order of things and to justify a certain lukewarmness in introducing advantageous measures, but no demonstration of the results of trial were afforded among the arguments against such a mode of instruction, for the simple reason that excepting feeble attempts, no serious experiments have been made. Even those attempts themselves were made without any particular energy and due observativeness.

We do not here take into calculation some of the at present existing technical schools of France, which possess sufficiently extensive school workshops *) because those schools belong rather to the lower class technical institutions and do not give to the world mechanical engineers and constructers, but only foremen (contremaîtres).

The slight acquaintance of learned technologists with practical work in mechanical workshops entails the unfortunate consequence that in the greater number of even very extensive works the practical part remains in the hands of routined artizans who have received no scientific instruction, but who have attained their exceptional position by accustoming themselves during the course of many years to the most obsolete methods of practice in the mechanical art.

Seldom do the rays of science penetrate that unenlightened sphere of labour and meanwhile it has so long demanded scientific guidance.

The *Imperial* Technical School of Moscow, the course of which from the theoretical subjects taught therein equals the course of many of the Polytechnical Schools of Western Europe, combines theoretical with practical education and consequently is enabled to present real proofs of the possibility and advantageousness of such combination since the trial of this combination has been made on an extensive scale and during a considerable lenght of time.

---

*) These are the schools of Chalons, Aix and Angers.

Every thing that we exhibited at the international exhibition relates exclusively to this, in our opinion, important question, and was exhibited in the desire of sharing with specialists in the work of technical education in the New World, all those results which have been attained by the School in the independent investigation of this special question.

For the practical education of young men in the two Branches,—mechanical engineers and mechanical constructers *)—the school possesses a large mechanical works with hired workmen, accepting ond carrying out orders from private individuals, and on a commercial footing, for the construction of steam engines, working engines, pumps, transmissions, agricultural machines etc **).

The works consist of the following shops: Joiners' shop, Engineers' shop, Erectors' shop, Painters' shop, a large Forge with steam hammer and fan blast, iron foundry with furnace for 3000 kilogr. of metal, and brass foundry; the works have also a drawing-office and counting-house attached to them.

---

*) Young men studying the technological engineering Branch are admitted to the laboratories instead of the mechanical workshops

**) These works execute private orders to the sum of from 35 to 46 thousand dollars annually.

A steam engine of thirty horse-powers is used for the working of the place, while the foundry with fan blast and coal pulverizing-mill are worked by an engine of ten horse-powers.

The works are under the management of the head mechanical engineer (vacant) and his assistant Platonoff, mechanical engineer.

The drawing-office is in the charge of Petroff, mechanical Engineer. All the mentioned persons have passed through the course of our school.

These works being within the walls of the institution itself and managed by well-instructed technologists, would be of important assistance in the instruction of young people, even if the young people took no active part the practical working of them.

But in order that the pupils may derive the greatest possible advantage from such auxiliaries, the sbool possesses, apart from the mechanical works and intended solely for the use of the pupils, school workshops: joiners' shop with turning lathe, pattern shop. metal turning, fitters' shop, smithy and moulding shop.

Every one of these shops is under the management of a technologist—specialist [*]) or of a skilled workman and their duty is to instruct the pupils in the rudiments of mechanical labour.

---

[*]) The wood turners' shop is in charge of Mr. Adelmann, the smithy—Mr. Bouroff, carpenters'—Mr. Michaeloff,metal turners'—Mr. Markoff, moulders'—Mr. Koumenius, and the fitters' shop—Mr. Sovetkin, mechanical engineer.

Every young man becomes acquainted, by fulfilling the obligatory programme, with all the work of mechanical art, namely: turning, fitting, carpentering and forging, in the school workshops and only then is admitted to the mechanical works.

We shall endeavour to speak further on the system of teaching the arts in the mechanical workshops of the school.

Up to the present time throughout the world, the workmen at industrial works and mills are usually self-taught. Any one who has himself been employed at a works and is familiar with the daily life of the workman in the different countries, must have perceived that the acquirement of knowledge and skill in any trade is to him a process much similar to the following: a boy of thirteen or fourteen years of age having entered a mechanical works to learn his trade, is put during the first few years, to work of an entirely unproductive kind and which has not the slightest relation to technics. He is made to carry water, sweep the workshop, crush emery, grind colours, etc. Only after the lapse of a few years and, probably, thanks to accidental circumstances, a chisel or a file is put into the hands of the youth and he is set to perform the rudest and simplest kind of work.

Then also if he happen to have neither father nor brother among the workmen around him, he begins learning his trade without a guiding hand and thus commences acquiring practical knowledge and skill in his trade by observing those about him in the workshop and by his own thought and calculation and impelled by the sole desire of attaining in as short a space of time as posible the position of a paid hand in the works. There can be no doubt that under such circumstances the acquire ment of skill by the new generation of workmen takes place in an extremely irrational manner and without any system; the amount of knowledge obtained depends upon accident and the time thus employed is of disproportionate length. Besides this, there is yet another inconvenience, namely that of specializing labour to too fractional a degree. The young workman placed accidentally either to a drilling or planing machine or a selfacting lathe, endeavours to remain as long as possible at his machine, encountering, it will be understood, no objection on the part of the heads of the workshops, since such specialization of labour redounds to the advantage of the proprietors, owing to the abundance of hands.

This order of things has the deplorable result that notwithstanding the long continued stay of the young workmen at mechanical works, and which is sometimes prolonged through the major part of the years of their manhood, well-taught and skilled fitters are almost everywhere rarely to be met with. This will be confirmed by all those constructors who demand skilled labour for the erection of models, and of the more or less delicately constructed instruments, machines and apparatus.

During the past few years endeavours have been continually made to open schools for the instruction of the workmen at all works of any considerable extent. The subjects taught in these schools are free hand and linear drawing, arithmetic and many others, in the supposition that practical hnowledge of works will be acquired in the works themselves.

From this it is impossible to conclude otherwise than society while taking measures to civilize the working classes. gives at the same time no attention whatever to the manner in which the young workmen acquire practical experience in their trades at the works; no endeavours have been made in that respect, and mean-while, as is our subjective opinion, the question is worthy of particular attention.

The conclusion however forces itself upon us that this question can hardly be entered into until the young well-taught technologist leaving Polytechnical Schools. shall themselves possess rational experience in practical hand labour. In order that their education as specialists shall be full and ample, such knowledge is indispensable in the highest degree, though until the present time it has unfortunately presented a prominent deficiency in their instruction. Who will not admit that the knowledge of the manner of executing given work is a necessity to one who has to issue the project of such work.

Acting on the principle that mechanical ingineers and mechanical constructers, whose future activity will be devoted pre-eminently to mechanical works, should have practical experience in the mechanical arts, the ***Imperial*** Technical School has employed every necessary measure for the solution of this difficulty in the best possible, manner.

In 1868 the School council considered it indispensable in order to secure the systematical teaching of elementary practical work, as well as for the more convenient supervision of the pupils while practically employed, to separate entirely the school workshops from the mechanical works in which the orders from private individuals are executed admitting pupils to the latter only when they have perfectly acquired the principles of practical labour.

By the separation alone of the school workshops from the mechanical works, the principal aim was, however, far from being attained; it was found necessary to work out such a method of teaching the elementary principles of mechanical art as, firstly, should demand the least possible lenght of time for their acquirement; secondly, should increase the facility of the supervision of the gradationary employment of the pupils; thirdly, should impart to the study itself of practical work the character of a sound, systematical acquirement of knowledge, and fourthly, and lastly, as should facilitate the demonstration of the progress of every pupil at every stated time. Every body is well aware that the successful study of any art whatsoever free hand or linear drawing, music, singing, painting, etc., is only attainable when the first attempts at any of them are strictly subject to the laws of gradation and successiveness, when every student adheres to a definite method or school, surmounting, little by little, and by certain degrees, the difficulties to be encountered.

All those arts, which we have just named, possess a method of study which has been well worked-out and defined, because, since they have long constituted a part of the education of the well-instructed classes of people they could not but become subject to scientific analysis, could not but become the objects of investigation, with a view of defining those conditions, which might render the study of them as easy and regulated as possible.

This, however, cannot relate to those arts which have been hitherto pre-eminently followed by the common and imperfectly educated class of workpeople, but a knowledge of which appears at the present moment, to be of importance to the educated technologist.

These arts are: wood-turning, carpentering, metal-turning, fitting and forging. From what we have already said, it will not be difficult to arrive at the reason of the absence of a strictly systematical method for the study of them, nor why the active working-out of such a method, without the aid of enlightened minds, may long remain deferred.

Meanwhile the necessity of such a method, more particularly for technical educational establishments, admits not of the slightest doubt, and the filling-up of this want promises evident advantages, not only in the matter of scientific technical education, but also with regard to the practical instruction of the workpeople, and consequently, the perfection of mechanical hand labour itself, which, from the introduction of specially adapted machinery is, year by year, perceptibly deteriorating.

If we except the attempts made in France in the year 1867 by the celebrated learned mechanical engineer

A. Cler, to form a collection of models for the practical study of the principal methods of forging and welding iron and steel, as well as the chief parts of joiners' work, and this, with a purely demonstrative aim—no one, as far as we are aware, has hitherto been actively engaged in the working out of this question in its application to the study of hand-labour in workshops. To the *Imperial* Technical School belongs the initiative in the introduction of a systematical method of teaching the arts of turning, carpentering, fitting and forging.

To the knowledge and experience in these specialities of the gentlemen entrusted with the management of the school workshops, and to their warm sympathy in the matter of practical education, we are indebted for the drawing-up of the programme of systematical instruction in the mechanical arts, its introduction in the year 1868 into the workshops, and also for the preparation of the necessary auxiliaries to study. In the year 1870 at the exhibition of manufactures at S'Petersbourg the school exhibited its methods of teaching mechanical arts, and from that time they have been introduced into all the technical schools of Russia.

The auxiliaries of education employed in teaching mechanical arts were exhibited at the international exhibition of Vienna and now at Philadelphia, in order that specialists in these matters might become acquainted with them.

The auxiliaries of education appointed for the teaching of any mechanical work whatever, for example—fitters' work, are classed in three categories; to the first of these belong the collections of instruments employed in fitters' work, with which the beginner must make himself perfectly familiar before entering upon work, and afterwards to use those instruments during the execution of the work itself.

To this category relate all those collections of models indispensable to the teacher of fitters' work, for the purpose of demonstration: the collection of instruments most in use for measuring, full size; the collection of instruments, full size, for drilling metals; the collection of instruments, full size, for finishing, from the smithy to the fitting shop inclusive *).

Models of files, increased to 24 times ordinary size, for the purpose of demonstrating the surface of the incision; the collection of models of instruments employed in cutting screws and nuts, increased six times ordinary size, for the study of the direction of the angles of incision; the collection of models of drills, increased six times, for the practical study of the cutting angles; and lastly, the collection of instruments and apparatus for teaching the tracing of yet unworked metal articles. We consider it our duty to draw the attention of specialists to this last collection, for the organisation of which we are indebted to our skilful instructor of fitters' work, Mr. Savetkin, mechanical engineer.

To the second category belong the collections of models appointed for the systematical and gradationary study of

---

*) This beautiful and ample collection could not be sent to the exhibition in consequence of the limited space allotted to us.

hand-labour in the fitters' art. These collections have the same signification with regard to the work of fitting as is allowed to scales and exercises in instruction in music. They are so ordered that the beginner may be enabled to overcome by certain gradations the difficulties which present themselves before him. It will be sufficient to glance at the adjoined detailed list of objects contained in these collections, and to examine attentively every object exhibited, to be convinced, that if the pupil, under the guidance of the teacher, carefully fulfil the study of all the numbers embraced in the collections, or rather the educational programme of the art of fitting, he must inevitably and in the most rational manner, render himself familiar with all the known practical hand-labour of this art.

Hence we arrive at the conviction, without any difficulty, that with such a system of teaching art the supervision of the teacher over the pupils and his observation of their progress become exceedingly easy. He need only remark that every number of the programme is executed satisfactorily by the pupil, and, putting the following one before him, give the requisite explanations for the succeeding work.

In such a case the fact of a great number of pūpils being occupied at the same time will present no great disadvantage, nor will it increase the arduousness of his duty to any considerable degree. And further, it will be a matter of impossibility that a pupil who has been working during a few years in the workshop, should fail to be able to use the drill or to trace a part to be worked. though he handle satisfactorily the chisel or the file.

To the third category belongs the collection of such articles or parts of machines as in the execution of which all the practical hand-labour of the fitters' art is successively repeated, having been acquired during the studies of the previous course.

What we have said in relation to the manner of study of the work of fitting, must be accepted also with regard to the other branches of labour, namely, wood-turning, carpentering, smithy and foundry work. We exceedingly regretted that the limited space allotted to us in the exhibition did not admit of our exhibiting all those collections of auxiliaries to instruction which the School has produced.

In conclusion we consider it our duty to observe that eight years have already elapsed since the programmes or instruction in the mechanical arts were introduced into the workshops of the school and they have been found to attain in the most brilliant manner the aim proposed in their introduction.

Victor Della-Voss.

Director of the School and ex-professor of
Practical Mechanics at the Agricultural and
Forest-Academy Petrofsky-Rasoumofsky.

SCHOOL WORKSHOPS.

I. WOOD-TURNERY.

Master F. Adelmann.

A. Collection of tools for turning wood.

№			
1. 2.	Screw-tools for thick worm......	1	couple.
3. 4.	D-to » » middle »	1	»
5. 6.	D-to » » fine »	1	»
7.	Rasps.........................	3	pieces.
8.	Planchet-files.....................	3	»
9.	Flat smooth files..................	3	»
10.	Three-square files................	3	»
11.	Augers...........................	3	»
12.	Scrapers.........................	2	»
13.	Screw-augers....................	3	»
14.	Augers middle....	3	»
15.	longer.....	3	»
16.	thicker....	2	»

17.	Skew turning-chisels	4	pieces.
18.	Gouges	3	»
19.	Skew-chisels	2	»
20.	Straight broad chisels	2	»
21.	Skew D-to	2	»
22.	Double skew D-to	2	»
23.	Point tools gouges	3	»
24.	Straight side tools	3	»
25.	Round D-to	3	»
26.	Sickle-shaped D-to	3	»
27.	Hooked D-to	3	»
28.	Cutting chisels	3	»
29.	Side hook and scraper	2	»
30.	Burnisher and milling wheel	2	»
31.	Skew chisels	3	»
32.	Round tools	4	»
33.	Bent broad chisels	3	»
34.	Straight D-to	3	»
35.	Round D-to	3	»
36.	Straight side tools	3	»
37.	Grooving tools	2	»
38.	Round side tools	3	»
39.	Hooked D-to	3	»
40.	Burins	2	»
41.	Fashion-chisels	3	»
42.	Cutting chisels	2	»
43	Awls	3	»
44.	Flat bent awls	3	»

from 45 to 60 general instruments.

45. Hatchet.
46. Hammer.
47. Screw cutting tools.
48. D-to.
49. D-to.
50. Piercing saw.
51. Crooked compasses.
52. Crooked and spherical compasses.
53. Straight spring-dividers.
54. Hand-vice.
55. Flat-nosed pliers.
56. Cutting nipper.
57. Round plyers.
58. Blow-pipe.
59. Glazer.
60 Flat emery grinding-stone.
61. Elastic chuck.
62. Fork-chuck.
63. Ring elastic chuck.
64. Cut out chuck.
65. Chuck for glue.
66. Chuck.
67 Chucks with displacing cheeks.
68. D-to with a center-screw.
69. D-to with a circular saw.
70. D-to with a brass ring for stretching.
71. Chuck for boring.

72. D-to.
73. Three-forked chuck.
74. Chuck with a crown-saw.
75. Chuck with a centrum bit.
76. D-to with a doudle centrum bit.
77. D-to with a fashion centrum bit.
78. D-to.
79. Chuck with a centrum bit.
80. D-to.
81. Chuck with a awl.
82.
83. D-to.
84.
85.

B. Collection of samples for successive learning of turning in wood.

PART I.

№
1 to 6. Exercise-models of various channellings.
7. Cylinder.
8. Cone.
9. Bullet.
10. Screws with nnts.
11. Segar-case.
12. D-to.
13. Vase with a cover.

PART II.

Casting-mould Models of details and Machines.

14. Cover for a stuffing-box № 43.
15. Shell for a Step.
16. Valve with a bullet seat.
17. Valve-seat at № 16.
18. Counter-weight for a governor.
19. Grease-cock.
20. Stuffing-box.
21-23. Suction pipe.
22. Cover of cut-off valves.
24. D-to at a valve-chamber.
25. Glands of pillow-block.
26. Pump piston.
27. Oil-cup.
28. Shell of a step.
29. Fly-wheel.
30. Separable coupling box.
31. Roller.
32. Star-wheel.
33. D-to.
34. Bevil-wheel.
35. D-to.
36. Cylinder-cover.

37. Hemp-packed piston.
38. Pulley.
39. D-to.
40. Cylinder-cover with a stuffing-box.
41. Step-pulley.
42. Muff.
43. Chamber of a bullet valve.

II. MODEL JOINERING.

Master A M. Michaeloff.

C. Collection of tools for joinery.

№

1. Large handsaw.
2. Bow-saw.
3. Lock-saw.
4. Saw for cutting grooves.
5. Round-nose-plane.
6. Smoothing-plane.
7. Double-trying-plane
8. Compass plane.
9. Tooth-plane.
10. Rabbet-plane double.
11. Rabbet-plane simple.
12. Rabbet-plane.
13. Fillister.
14. Round plane.
15. Cornice-plane.
16. Fashion-plane.

17. Hollow-plane.
18. Grooving-plane.
19. Plough.
20. Ploughbit at № 19.............. 2 pieces.
21. D-to..................... 2 »
22. Slip.
23. Oil-stone.
24. Compass-plan double.
25. Mallet.
26. Convex plane.
27. Saw-wrest.
28. Saw-set.
29. Felling-saw.
30. Hatchet.
31. Round drawing-knife.
32. English drawing-knife.
33. Scraper.
34. Bench-hook with a spring.

D. Collection of tools for joinery.

1.	Ripping-chisels	6	pieces.
2.	Gouges	6	»
3.	Flat gouges	6	»
4.	Mortise-chisels for joiners	3	»
5. 6.	Mortise-chisels for carpenters	4	»
7.	Rasps round and half-round	3	»
8.	Bastard files flat and half-round	2	»
9.	Nail-nippers.		

10.	Screw-driver.		
11.	Bench-hammer.		
12—15.	Wood-screw-plate and screw-tap.	2	pieces.
16.	Screw augers	3	»
17.	Spiral drills	3	»
18.	Shell augers	2	»
19.	a) Joint-compasses. b) Spring-dividers.		
20. 21.	Scales of measuring.		
22. 23.	Hand braces.		
24.	Angle-brace or corner-drill		
25.	Centrum-bits	10	»
26.	Shell-bits	10	»
27.	Counter-sinks.	10	»
28.	D-to:	4	»
29.	Screw-drivers at № 22 and 23.		
30. 31.	Universal centrum-bits.		
32. 33.	American spiral drills for hand braces.	6	»
34.	Gimlets	2	»
35.	Back-square.		
36.	German marking-gauge.		
37.	Marking-gauge with 2 points.		
38.	Carpenter-awl.		
39.	Mitre-square.		
40.	Back-mitre-square.		
41.	Sliding-square.		
42.	Instrument for marking of bevil-wheels.		

43. Caliber-compasses.
44. Inside-callipers.
45. Plumb-level.
46. Caliber-compasses for bevil-wheels.

E. Samples for successive learning of joiner and pattern making.

1. Sawing in a straight line and along fiber
2. Sawing in a curve line.
3. Planing of wood of a square section.
4. Planing of wood of a octagonal section.
5. Planing of wood of a hexagonal section.
6. Planing of wood of a triangular section.
7. Planing of wood of a toothed section.
8. Planing of wood of a compound section.
9. D-to.
10. Preparing for interior sawing out.
11. Interior sawing out.
12. Cross-scarving.
13. Joint by a passing tenant.
14. Joint by an interior tenant.
15. Joint by means of a swalow-tail.
16. Joint by an interior tenant.
17. Mitred quoin.
18. Joint by means of an interior tenant with chamfe
19. Joint by a key.
20. Joint by tongues.
21. Edge-joint by grooves and dovetail-spikes.

22. Joint under acute and obtuse angles.
23. Edge-joint with a chamfer and channel.
24. Edge-joint by a mitre-dovetail.
25. Cross-scarving by a skew abutting.

F. Collection of models of usual wood-joinings.

1. Tongue-joint.
2. Rebated joint.
3. Joint by tenons.
4. Joint of folding-floors.
5. Joining of two boards by dovetail-tenons.
6. Skew scarf.
7. Double tenon.
8. Double skew scarf.
9. Skew scarf with a key.
10. Scarf.
11. Scarving by a cross-notching.
12. Straight tenon with a skew abutting.
13. Cross joint with a skew abutting.
14. Scarving by a tail and key.
15. Joint of two timbers by tabled scarf.
16. Skew joint with a simple abutting.
17. Skew joint by a tenon and double abutting.
18. Cross joint with chamfer and channel.
19. Star joint.
20. Truss joining.
21. Skew joint of round-timbers by a tenon and simple abutting.

22. Frize-joining.
23. Frame-joining with panel.
24. Corner notching of round-timbers.
25. Corner notching of timbers hewing upon one side.

G. Collection of patterns for iron castings.

1. Fire-grate bar.
2. Crank.
3. Puppet.
4. Wall-box.
5. Cheave-drum.
6. Eccentric.
7. Hoop of eccentric-rod.
8. Puppet for a turning-lathe.
9. Sliding-puppet.
10. Plummer block.
11. Hanger.
12. Hanger of Sellers.
13. Brasses of hanger at № 12.
14. Oil-cup at № 12.
15. Frame at a hand-drilling-engine.
16. Bevel-wheel for wood-teeth.
17. Bevel-wheel.
18. Horizontal feed-pump.

III. FORGE.

Master S. Bouroff.

H. Collection of forging tools.

№		
1.	Iron square.	
2.	D-to arsheen (russian ell).	
3.	Jaws.	
4.	Joint-compasses.	
5.	Gap-gauges.	
6.	Callipers.	
7.	Oval steel mandril.	
8.	Square and hexagonal steel mandrils.	
9.	Round steel mandrils..............	8 pieces.
10.	Conical steel mandrils..............	2 »
11.	Rings of the tong-handles..........	2 »
12.	Little nut mandril.	
13.	Greater nut mandril.	
14.	Heading-tool.	
15.	Round heading-tool.	
16.	Heading-tool for round heads.	

17. Heading-tool for hexagonal heads.
18. D-to for square heads.
19. D-to for nuts with a square adjoint.
20. D-to for conical heads.
21. First sledge-hammer.
22. D-to with a pane.
23. Great planishing-hammer.
24. Middle d-to.
25. Little d-to.
26. Set-hammer with a round edge.
27. D-to flat.
28. D-to one-sided.
29. D-to narrow.
30. D-to great half-round.
31. D to little.
32. Punch-hammer.
33. Square drift.
34. Round drift.
35. Trimming chisel.
36. Trimming chisel with a groove.
37. Top-swage for half-round heads
38. Coner-hammer.
39. Half-round sinking hammer.
40. Top-swage for fashion heads.
41. Bottom-swage at № 40.
42. Great half-round bottom-swage.
43. Middle d-to d-to.
44. Little d-to d-to.
45. Flat bottom-swage at № 29.
46. Great bottom-swage at № 30.

47. Little bottom-swage at № 31.
48. Red-chisel.
49. Hand-hammer with a cross pane.
50. D-to with a length pane.
51. a) Forge-tongs with a flat bit.
    b) D-to with a round bit.
    c) D-to for forging of flat iron.
    d) D-to for square bar-iron.

I. Samples for successive learning of blacksmith's manipulations.

1.	Forging of square-iron out of round-iron.	
2.	D-to round iron out of square-iron.	
3.	D-to octagonal out of square-iron.	
4.	D-to hexagonal out of round-iron.	
5.	Square nuts	2 pieces.
6.	Hexagonal nuts	2 »
7.	Screws with spuare heads	3 »
8.	D-to with round heads	3 »
9.	D-to with hexagonal heads	2 »
10.	a) D-to with a spherical head.	
	b) D-to with a sunk head.	
11.	Square-headed bolts	2 »
12.	Flange bolts	2 »
13.	Spherical-headed bolts	2 »
14.	Bored key	2 »
15.	Flat-headed bolts	2 »
16.	Bolts with an eye	2 »

17.	Flat iron with eye	2	pieces.
18.	a) Round flanges b) D-to with ears	2	»
19.	Welding of round iron	3	»
20.	D-to	2	»
21.	Welded conical pipe with an ear	2	»
22.	Various turning-joints	3	»
23.	Flat-iron bent to a right-angle	6	»
24.	Welded handles	2	»
25.	D-to	2	»
26.	Spanners welded from a whole piece of iron	3	»
27.	a) Bent squares. b) Welded squares.	4	»
28.	Steeled iron	4	»
29.	Cross from a whole piece of iron	2	»
30.	Welded cross	2	»
31.	Steeling of a hammer-face	4	»
32.	Welded ears to a square bar-iron	3	»

IV. METAL-TURNERY.

Master A. M. Markoff.

J. Collection of tools for turning metal.

№

1-3. Center punches.
4. Straightening-hammer.
5. } Center-finders.
6. }
7. Chipping chisel.
8. Half-round movable hook-tool with a help handle.
9. Half-round hook-tool.
10. Pointed hook-tool.
11. Flat heel-tool (large).
12. D-to (narrow).
13. Cutting hook-tool.
14. Skew hook tool.
15. Half-round hook-tool with a help handle.
16. Round tool.
17. Flat tool.
18. Point tool.
19. Turning-graver.

20. Cutting-graver.
21. Large flat chisel.
22. Skew flat chisel.
23. Help hook.
24-26. Tools for turning of metal balls.
27. Spanner at № 24, 25, 26.
28-30. Grippers with binding-screws.
31. Right angled chuck.
32-34. Grippers.
35. Spanner at № 32, 33, 34.
36-38. Yeu plates.
39. Spanner at № 54, 55.
40. Middle plate.
41-43. Screw-cheeks.
44. El-square.
45-47. Plates.
48. Straight edge.
49. Callipers.
50. Inside-callipers.
51. Callipers.
52. Caliber in millimetres.
53. D-to in inches.
54.
55. } Grippers with movable centers.

K. Collection of tools for turning metal.

1-3. First bits.
4-6. Flat drills.
7-9. Flat pin-drills.

10. Help-hook for drills.
11. Movable help-hook for drills.
12. Forge-tongs with a flat bit.
13. Slide-rest round tool.
14. Slide-rest right flat tool.
15. Slide-rest left flat tool.
16. Narrow flat tool.
17. Flat cutting tool.
18. Dent-holder for cutting inside screws.
19. Holder with a movable fashion-tool.
20. Spanner at № 18 & 19.
21. Normal spindle for milling-wheels.
22. Milling-wheels.
23. Milling-tool.
24-28. Holder with round tools and spanner. Great caliber.
29-34. Holder with triangular section tools and spanners.
35-39. Holder with round tools and spanner. Little caliber.
40. Hammer with handle for driving out turning-pikes.
41. Hammer for driving out turning-pikes.
42-53. Screwing-tools from $^7/_{16}$ to $1\,^1/_2$ inches diameters according to Whitworth's scale.
54-59. Thread-wheels for screwing tools from $^7/_{16}$ to $1\,^1/_2$ inches.

60. 61.	Cylindrical pikes...............	6 pieces.
62. 63.	Conical pikes..................	6 »
64.	Nut-pikes for $^3/_8$ to $1\,^1/_2$ inches nuts.	6 »
65.	Washer-pikes for $^3/_8$ to $^7/_8$ inche boring.	5 »
66.	Water-can.	

67. Oil-can.
68. Water-can.
69. Round bastard file.
70. Three-square smooth file.
71. Flat smooth file (little).
72. Half-round d-to.
73. Flat smooth file (great).
74. Half-round bastard-file.
75. Emery cheeks.

L. Samples for successive learning of turning metal.

1. Cylinder.
2. Bolt with a cylindrical head.
3. Handle for a vice.
4. Bolt with a fashion-head.
5. Handles.
6. }
7. } Exercise-models of various channellings.
8. Stepped gauge from $^1/_8$ to $1^1/_2$ inches.
9. Fly-wheel.
10. Pulley.
11 Cylinder with a cylindrical boring.
12. D-to with conical boring.
13. Sheel for a step.
14. Ball turned upon an axle.
15. Ball turned without an axle.
16. Cone.
17. Various plummets.

18. Screw and nut cut by screwing tools.
19. Drill-borer.
20. Stop-cock.
21-24. Various grease-cocks
25. } Conical valves.
26. }
27. Hemp-packed piston.
28. Ball valve.
29. Governor-weight.
30. Red brass pillow for a connecting-rod.
31. Sheave-drum.
32. Stand and movable socket for marking-gauge.
33. Guide-pulley.
34. Eccentric with a hoop and rod.
35. Step-pulley.
36. Cylindrical wheels.
37. Bevel-wheels.
38. Right and left worms of a screw.

M. Samples for successive learning of turning metal.

39. Steam-cylinder.
40. Steam-piston with a brass-ring.
41. Cylinder cover.
42-50. Parts of a cutt-off valve and governor-valve.
51. Ball-joint.
52. Cock with double flanges.
53. Cross-head.

54. Crank.
55. Hemp-packed piston.
56. Bevel-wheel turned by metal-gauge.
57. Steam-piston with two cast-iron rings.
58. Eccentric with hoop.
59. Cranked shaft.

V. SCHOOL FITTING SHOP.

MASTER D. K. SOVETKIN, MECHANICAL ENGINEER.

Models for the practical study of the construction of cutting instruments.

Taking into consideration the importance of a knowledge of the proper construction of instruments, and the difficulty which has to be overcome in explaining to a whole mass of pupils the minutest details in connexion with the direction and the angles of the incisive portions of instruments, we, already in the year 1872 endeavoured to construct wooden models, representing instruments on a considerably increased scale. Part of these models was exhibited by us at the Polytechnical Exhibition of Moscow, in the year 1872.

Models of instruments on an increased scale present the advantage of rendering it possible for the student to see clearly all the minutest details of the construction of the instrument. The direction of the cutting edges and also the shape and direction of the level surfaces which form the working part of an instrument should be studied in the most detailed manner, and how is this possible when those portions of an instrument are hardly to be seen by the unaided sight. Let us take for an example the cut of a smooth-file; is it possible to form a clear comprehension of the shape and direction of the teeth without the aid of the lens? Certainly not. If then we form the tooth of the file increased to twentyfour times the ordinary size, all the surfaces around it will be presented as practically clearly, as will enable one not even engaged in the special study of the matter to form a clear idea of the shape of the tooth of the file. At the present moment we submit to the appreciation and judgment of the interested public models of the cutting parts of files, drills and instruments for the cutting of the screw, outside as well as inside.

The three following lists will serve as the basis of the entire range of the collections which represent all the instruments emplohed in work.

N. Models of drills and countersinks increased 6 times of ordinary size.

1. Model of cutting edges of a drill (double cutting) for drillbow.
2. Model of cutting edges of a drill (one cutting) for drill-bow.
3. Model of cutting edges of a drill for crank-brace.

4. Model of cutting edges of a center-bit with long point.
5. Model ef cutting edges of a center-bit with short point.

Remark. In models № 1—5 are clearly seen the shapes of the cutting edges, and also the angles of the working surfaces. From an examination of these drills it will be easily seen the work of such instruments cannot be called good by reason of the irregular direction of the working surfaces.

6. Model of cutting edges of a drill, which edges have the favourable angles for the work.
7. Model of cutting edges of an american spiral-drill, distinguished by stability and exact work.
8. Model of cutting edges of a drill for boring turning-joints.
9. Model of cutting edges of a drill for half-ball borings.
10. Model of cutting edges of a fashion drill.
11. Model of cutting edges of a cone-countersink for wrought-iron and cast-iron.
12 Model of cutting edges of a cone-countersink for brass.
13. Model of cutting edges of a hemisphere countersink.
14. Model of a drill-stock with the cutter showing his cutting edges and fastening.

O. Cutting parts of files increased 24 times ordinary size.

1. Tin-file.
2. Rasp-cut for lead and soft allayage of metals.
3. Sample of the first-course of files for hard metals, in order to show the angles of the working surfaces and cutting edges.
4. Sample of the first-course and second-course, in order to show the beginning of file-teeth
5. Sample of the first-course of a smooth-file, in order to show the angles and form of the working surfaces.
6. Sample of the second course for smooth-files.
7. Sample of the second course of a fine-cut rasp, in order to show the proportions of teeth.
8. Sample of the second course of a armfile, in order to show the proportions of teeth.

Remark. The three last samples show clearly and practically the size of the teeth of the most used files.

P. Screw-cutting tools, increased 6 times ordinary size.

1. Model of a screw-tap with conical nucleus and thread.

2. Model of a screw-tap with cylindrical nucleus and conical thread.
3-6. Models of screw-taps for nuts having holes not going through (complete assortment).
7. Model of part of a screw-plate for cutting external screw-threads.
8. Models of screw-dies with obtuse cutting angles.
9. Models of screw-dies with right cutting angles.
10. Models of Whitworth's screw-dies.

Q. Collection of instruments employed in making apertures of various shapes.

1. Crank-brace.
2. Crank-brace with binding-screw
3. Ratchet-brace.
4. Crank-brace for two borers.
5. Ratchet-brace without spring.
6. Ratchet-brace for narrow space.
7. Ratchet-brace with joint-handle.
8. Ratchet-brace with continual going.
9. Drill-borer.
10. Drill-bow.
11. Archimedean drill-stock.
12. Drill-box.
13. Drill-box with continual going of the drill-bow.
14. Coners for various centre-recesses... 3 pieces.
15. Punches for plate metals.......... 3 »
16. D-to for round apertures........ 3 »

17.	Punches for square apertures	3	pieces.
18.	D-to for flat apertures	3	»
19.	Borers for № 11, 12, 13	5	»
20.	Borers for № 9	5	»
21.	Borers for ratchet-brace and crank-brace	7	»
22.	Borers for № 6	6	»
23.	American spiral-drills	6	»
24.	Countersinks for drill-stock	2	»
25.	Countersinks for ratchet - brace and crank-brace	3	»
26.	Fashion-borers	4	»
27.	Broachs of various forms	9	»
28.	Cutter-bars	4	»
29.	Boring-bar for cylindrical countersink.		
30.	Boring-bar for ring-countersink.		
31.	Countersinks for inside apertures	3	»
32.	Boring-bar for special works.		
33.	Boring-bar with mechanism for boring annular recesses perpendicular or inclined to given aperture.		
34.	Drifts for square apertures	5	»

R. Collection of instruments of measurement used in studying the art of fitting.

1.	Rules	2	»
2.	Rules for cylinders	6	»
3.	Squares	3	»
4.	Back-squares	3	»

5. Angle-gauge for hexagon.
6. Angle-gauge for octagon.
7. Sliding-square.
8. Instrument for marking of bevil-wheels.
9. Pattern for centre-bit.
10. Pattern for heads of borers.
11. Rule divided into inches and metres.
12. Folding scale of measuring.
13. Slide-gauge.
14. Double slide-gauge.
15. Slide-gauge with a nonius.
16. Slide-gauge with a micrometrical screw.
17. Number-gauge for metal plates.
18. Gauge for screws and nuts.
19. Stepped gauge into millimetres.
20. Stepped gauge into inches.
21. Gauge for determining of thickness (tachometer).
22. Beam-compasses.
23. Beam-compasses with a micrometrical screw
24. Compasses.
25. Compasses with an arc.
26. Compasses with an arc and put in foots.
27. Spring dividers.
28. Inside-callipers with a binding-screw.
29. Inside-callipers with a binding-plate.
30. Callipers.
31. Callipers with a binding-screw
32. Double callipers.
33. Springy callipers.

S. Samples for successive learning of filer's trade.

COURSE I.

Time for study 240 hours.

1. Cleaning of cast-iron.
2. Chiselling of simple forms out of boiler-plate.
3. Chiselling of complex forms out of boiler-plate.
4. Chiselling of planes.
5. Chiselling of convex conical surfaces.
6. Chiselling of concave conical surfaces.
7. Filing of thin edges according to marking lines.
8. Filing of planes.
9. Filing of two parallel planes.
10. Filing of two rectangular planes.
11. Filing of two acute-angled planes.
12. Filing of two obtuse-angled planes.
13. Filing of inside obtuse-angle according to pattern.
14. Filing of inside acute-angle according to pattern.
15. Filing of planes of a cube.
16. Filing of planes parallelly a given axis.
17. Filing of a hexagonal prism.
18. Filing of plane and crooked surfaces according to a given geometrical axis.
19. Filing of a plane with two flanges.
20. Filing of a plane with three flanges.

21. Filing of a plane with four flanges.
22. Filing of a rectangular groove.
23. Filing of an acute-angled groove according to pattern.
24. Filing of a going out acute-angle according to pattern.
25. Filing of a pyramidal groove.
26. Filing of a conical groove.
27. Filing of a convex conical surface.
28. Filing of a cylindrical groove according to pattern.

T. Samples for successive learning of filer's trade.

COURSE II.

Time for study 240 hours.

29. Filing of a truncated cone according to pattern.
30. Filing of a plane with cast square prism.
31. Filing of a cast square prism according to a given basis.
32. Filing of cast prismatical apertures.
33. Filing of cast cylindrical apertures.
34. Filing of cast pyramidal apertures.
35. Filing of cast conical apertures.
36. Punching of round holes with rugged edges.
37. Punching of round, square and flat holes.
38. Boring of thorough holes and not thorough holes.
39. Boring of cast holes.

40. Borings under various angles and of various forms.
41. Boring of slits.
42. Boring of figures.
43. Boring by counter-sink by thorough holes.
44. Boring by counter-sink by not thorough holes.
45. Drilling of key-slots.
46. Drilling of holes which centre not be situated on the worked piece.
47. Drilling of great holes.
48. Drilling of not thorough holes.
49. Screwing of bolts and nuts.
50. Cutting of screws for wood.
51. Stamping of screws according to system Belieff.

U. Samples for successive learning of filer's trade.

COURSE III

Time for study 240 hours.

52. Filing of key-ways.
53. Filing of an eye according to a given geometrical axis.
54. Filing of a socket with axles according to given two rectangular axises.
55. Filing of a crank according to two given parallel axises.

56. Filing of two parts the geometrical axises of which are in one line, when divided by a plate.
57. Filing of keys and chiselling of key-ways.
58. Filing of a helicoidal surface.
59. Filing of teeth of a bevel wheel.
60. Filing, scraping, smoothing of two planes.
61. Fitting of two rectangular parts.
62. Fitting of two obtuse-angled parts.
63. Fitting of two acute-angled parts.
64. Fitting of two convex and concave parts.
65. Filing of teeth of a rack.
66. Fitting of the strap ard head of the connecting-rod to each other.
67. Fitting of a cover to a plummer-block.
68. Fitting of brasses to a plummer-block.
69. Fitting of ends of a shaft by scarving for coupling.
70. Fitting of ends of a shaft by hooked scarving for coupling.
71. Fitting of a toothed coupling.
72. Fitting of a clutch coupling.
73. Fitting of brasses to a plummer-block by five planes.
74 Fitting of a parallelopiped to aperture.
75. Fitting of sliding plates.

Remark. The method of systematically teaching the art of fitting was first worked out in the ***Imperial*** Technical School of Moscow in the year 1868, and after a four years' trial has proved of immense advantage to the School itself as well as to those of the Russian technical schools which borrowed that method of the Moscow Technical School at the time of the Petersburg exhibition of the year 1870.

In attestation of the utility of the proposed systematical method of teaching, we may observe that immediately afteb its being presented to the public in the year 1870, the *Imperial* Technical School received orders for similar collections from technical schools in Moscow, Petersburg and Odessa.

V. A bench, instruments and apparatus for marking and lining machine-parts to be worked.

A bench on three legs with screws for the horizontal fixing.

1. Two puppets for the placing of machine-parts, which are centered.
2. Frame for the vertical fixing of machine-parts for their lining; the same will be used in special cajes as pressing-screw.
3. Scriber-block of a constant height equal that of the puppets.
4. Little standing marking-gauge for the horizontal lining with a radially movable scriber.
5. Middle standing marking-gauge with a parallelly movable scriber.
6. Great standing marking-gauge, worked out gase-pipes.